DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange among interested persons of information concerning recent developments in various digital computer [illegible]. Distribution is limited to government agencies, [illegible] and contributors.

OFFICE OF NAVAL RESEARCH • PHYSICAL SCIENCES DIVISION

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Approved by
The Under Secretary of the Navy
16 August 1954

COMPUTERS, U. S. A.

ABERDEEN PROVING GROUND COMPUTERS

The following statistics show the machine hours for the three high-speed computers for the "average" week for the period 0800 20 May 1955 to 0800 12 August 1955:

	ORDVAC	EDVAC	ENIAC
A. Engineering Time			
1. System Improvements	9.94	0.76	2.81
2. Engineering Servicing	36.73	25.95	50.30
Total Engineering	46.22	26.71	53.11
B. Chargeable Time			
1. Code Checking	26.25	24.53	0.32
2. Production	51.51	72.14	5.38
Total Chargeable	77.76	96.67	5.70
C. Non-Chargeable Time Due To			
1. Machine Causes	6.26	2.21	1.48
2. Non-Machine Causes	24.76	20.06	2.06
Total Non-Chargeable	31.02	22.27	3.54
D. Idle Time	12.24	21.95	98.66
E. Standby Time	0.76	0.39	6.99
GRAND TOTAL	168.00	168.00	168.00

A synchronous magnetic drum for EDVAC was placed in operation in March 1955. The drum was designed and built by BRL personnel. It has a total capacity of 4,608 words. Transfer to and from the drum takes place at a pulse rate of one million per second so the actual transfer rate exclusive of access time is approximately 20,000 words per second.

The average access time is 15 milliseconds. There is no fixed block length. Any number of words from 1 to 384 may be transferred with one order. The 1st and 3rd address of EDVAC's four-address code determine the number of words to be transferred. The second address specifies the location around the circumference and the fourth address specifies the channel. Regular computing on ECVAC utilizing the drum has proved the reliability of the drum.

A magnetic drum storage system was added to the ORDVAC in July 1955. This system provides 10,032 words of auxiliary medium-access storage, and it greatly increases the computing capability of ORDVAC. Transfer of information is carried out in blocks of 48 words. One operation may involve any 48 consecutive locations in the electrostatic storage and any one of 209 possible tracks on the drum. The time required to carry out one drum transfer operation is about 80 milliseconds.

IBM DATA PROCESSING CENTER

International Business Machines Corporation has opened its new electronic data processing center on the main floor of the company's headquarters in New York City. The center contains a complete lineup of high-speed digital computers and data processing equipment. Included are

the IBM 702, 701, and 650 electronic data processing machines as well as smaller, medium-sized electronic calculators.

This versatile combination of machines makes available on an hourly charge basis the latest tools for scientific management to companies which do not need full time data processing facilities of such capacity and speed and to companies whose own facilities are overloaded.

For major business applications, there is the 702, which is available for rental at a basic hourly charge of $445

For large scale scientific and engineering calculations, there is a 701. It has been available on an hourly charge basis at IBM's headquarters in New York for over two years and, operating around the clock, has handled a variety of complex assignments for business, industry, and government.

For either business or scientific work on a smaller scale, the center has a 650 Magnetic Drum machine. It is the first of its type to be shown publicly by IBM in New York City. The 650, a card-input, card-output machine, will now also be available as a tape-operated machine with a printer output.

Also in the processing center are smaller accounting machines, such as the 604 Electronic Calculator—costing $15 an hour—and other punch card equipment. One of these machines is the IBM Data Transceiver which permits companies to make rapid use of the center's processing facilities from remote points. Westinghouse Electric Corporation, in Pittsburgh, is currently using the center's 701 via Transceiver to solve engineering design and development problems.

THE INSTITUTE FOR ADVANCED STUDY (Electronic Computer Project)

Since higher speeds will be useful in a future computing machine design, a program has been under way to evaluate possible speed increases in the basic operations of which the various orders are composed. Initially a parallel machine of the simplest type will be assumed, leaving for later consideration those speed-ups which can be accomplished by using greater complexity, e.g. matrix or semi-matrix multipliers; allowing more than one process to occur a given time, etc.

For convenience one may think of the basic machine operations as consisting of either serial information transfers or parallel information transfers. The parallel transfers are further divided into those within the arithmetic unit and those between the arithmetic unit and the memory. Three basic operations are then distinguished:

1) serial or "carry" operations,

2) parallel or "shift" operations, and

3) memory access or "cycle" time.

A significant improvement in carry speed has been achieved partly by using fast gating circuitry but more importantly by using the average properties of carry sequences. It has been shown that on the average the longest carry sequence resulting from the addition of two 40 digit numbers is only five stages. In most present adders, time is always allowed for a possible 40 stage carry. A circuit has been developed here which provides a signal whenever actual carries are complete and therefore utilizes the above average time saving of 8 to 1. An eight stage experimental accumulator has been built embodying this carry circuit. Measurements show an average carry time of 0.21 microseconds.

A major revision of the input-output organ of the IAS machine has been planned. This revision was in part dictated by the acquisition of a new drum of 12,000 word capacity. Provision is being made for handling not only the new drum but also the existing IBM input-output as well as possible future tape equipment. The new organ consists of a common control and buffering register in one cabinet and the specialized drum, IBM, and possible tape controls in their own cabinets.

JOHNNIAC (Rand Corporation)

The JOHNNIAC computing system is essentially complete now except for tape units which are to be added this winter. At present the JOHNNIAC has punched card input, punched card and a 900 line-per-minute printer output, 4,096 word core store, and a 12,288 word magnetic drum. It also has a combined operator's and maintenance console. In addition to controlling the operation of the machine, the operator's section of the console has facilities for displaying and modifying the contents of any register by means of a novel octal display and keyboard arrangement. The maintenance section of the console has provision for monitoring or changing the state of any toggle in the arithmetic and control sections; in addition it houses manual marginal testing, core store testing and supervisory control facilities.

Mean free time between error figures for the past two months of operation (327 hours of operable time) are stated below for the sections of the machine which are considered completed and debugged. All units except the drum and console are listed.

Section	Mean free time between errors in hours
Arithmetic and Control	109
AC and DC power supplies and Control Equipment	109
Printer	109
Punched Card Equipment	47
Core Store	33 *

*The mean free time figure for the core store is approximately 100 hours if the tube #5965 failures described in the next paragraph are not counted.

The 4096 word core store is now in its fifth month of operation. The mean free time between errors for operable time during the first four months was 37 hours. During one month (128 hours) there were no errors ascribable to the core store. The low average mean free time figure (37 hours) for the core store is due to the failure of 21 of sixty-five #5965 tubes from a particular manufacturer. The failures were caused by insufficient heater coating which resulted in shorted heater loops, which in turn resulted in a higher voltage gradient across the remainder of the heater. After a few hundred hours, the heaters became brittle enough to open under a slight mechanical shock. #5965 tubes from two other manufacturers are used in the store and have given satisfactory service.

The JOHNNIAC is presently operated on a two-shift per day basis. The per cent computer operable time of scheduled computing time on single shift operation for the past two months has been 90%. The per cent operable time of "power on" time has been 79%. "Operable time" is "scheduled computing time" minus "unscheduled maintenance time" and "problem rerun time" due to machine errors. Scheduled computing time is the period (currently 7-1/2 hours per shift) during which the machine is turned over to the users and is "power on time" minus "scheduled maintenance and engineering change time."

GEORGIA INSTITUTE OF TECHNOLOGY (Rich Electronic Computer Center)

Georgia Tech recently completed and occupied an addition to its Research Building which houses the Rich Electronic Computer Center, a division of the Engineering Experiment Station. Both an ERA 1101 computer and a CRC 102D computer were installed during August. Machine time is now available for sponsors.

Under the direction of Dr. E. K. Ritter, who came to Georgia Tech from the directorship of the Computation and Ballistics Department of the U.S. Naval Proving Ground at Dahlgren, Virginia, an experienced staff has been organized to conduct a three-phase program: (1) Education in all phases of high-speed digital computation: (2) Research in the field of electronic digital computers, and (3) Service to industry, business and government. The technical staff of the Rich Electronic Computer Section includes: Dr. W. F. Atchison, W. A. Bezaire, J. T. Collins, Barbara J. Daniels, Dr. B. M. Drucker, R. E. Eskew, W. W. Jackson, E. W. Manseau, T. R. Morel, Dr. I. E. Perlin, C. P. Reed, Jr., G. E. Sprague.

NATIONAL BUREAU OF STANDARDS AUTOMATIC COMPUTER (SEAC)

During the period April 1 through June 20, SEAC was used for 51 tasks in progress in the Applied Mathematics Division. Schedules computation time was distributed as follows:

Total scheduled time available for computation		-- 1,333 hours
Gross operating time		-- 1,000 hours
Productive operation	837 hours	
Code checking	163 hours	
Time lost during or following malfunction		-- 333 hours

Considerable use has been made of an interpretive system for handling numbers in floating decimal point representation called Base 00. It includes single instructions for performing the arithmetic operations, log x, $\sqrt{x}$, binary-to-decimal conversion, decimal-to-binary conversion, sin x, cos x, x^n, e^x, movement of a block of numbers, and comparisons. A technical memorandum describing the operation and use of this system has been prepared.

On an experimental basis the following subroutines and supervisory routines have also been included in the Base 00 system:

(1) a supervisory routine for accelerating the rate of convergence of certain iterative processes

(2) a supervisory routine for quadratic interpolation

(3) a general purpose routine for generating iterative loops.

The n code words which are to be repeated with suitable modifications are preceded by a single word whose first three addresses are n, m and p. This word indicates that the n succeeding words (instructions) are to be repeated either m times or until the number in cell p is less than the number in cell m. The addresses in each instruction being repeated can be modified each time the instruction is repeated, and the specifications for these modifications are carried by each instruction itself. An an example, a table of values $y_i = ax_i + z_i$, $i = 1(1)m$, can be computed from tables of x_i and z_i using the iterative loop generator and only three computer instructions.

NAVAL AIR MISSILE TEST CENTER (Point Mugu, California)

A contract has been awarded to Computer Control Company, Inc. for the design and development of Input and Output terminal equipment for the RAYDAC computer at the U.S. Naval Air Missile Test Center. Completion date is scheduled for December 1957.

The equipment will provide for directly connected IBM card input in decimal, binary, and alphanumeric form. High speed paper tape and electronic inputs from special coded sources will also be available.

RAYDAC will be able to directly load 8 words into core storage for output line printing, or card punching. Printing will be decimal or alphanumeric with very flexible format control. Punching will be decimal, binary, or alphanumeric. Alternatively, the line printer or punch can be connected to an auxiliary magnetic tape for larger amounts of output.

Checking features comparable to the powerful checking used in RAYDAC will be incorporated in the new facilities.

Mr. Robert W. Brooks has recently been elected President of Computer Control Company, Inc. Mr. Kenneth M. Rehler, Vice President, will represent the company in West Coast operations. Dr. Louis Fein has resigned from the company.

An IBM 650 Magnetic Drum Calculator was installed 29 April 1955 and has been in operation since that date. Initial project of subroutine setup and programming of standard jobs has been completed. Current effort is being applied to a three address interpretative routine and completion of matrix, harmonic analysis and polynomial solution routines.

NAVAL AIR TEST STATION (Patuxent River, Maryland)

The Naval Air Test Center expects to receive delivery early in November 1955 of a Datatron electronic digital computer. Receipt of this equipment will provide the nucleus of a digital computing facility for the Naval Air Test Center. The facility will operate under the direction of Mr. R. A. Sweet of Armament Test for the Naval Air Test Center. The facility will use perforated paper tape as the input medium which will be read into the computer via an ElectroData high speed photo-electric perforated tape reader. The equipment will be used in the processing of experimental test data obtained by the various divisions of the Naval Air Test Center in evaluating new naval aircraft and their armament control systems. It is planned to add magnetic tape auxiliary storage and input-output facilities to the installation early in 1956.

The installation of this equipment will be the first phase of a longer term plan to mechanize as completely as possible the data reduction processes at the Naval Air Test Center. The over-all plan envisioned includes magnetic tape recording of the raw data using airborne recording equipment. This data will then be edited and digitized in ground based facilities and recorded on a second magnetic tape in a form compatible with the magnetic tape inputs of the Electro-Data computer.

NAVAL PROVING GROUND CALCULATORS

The Naval Ordnance Research Calculator (NORC) has been in productive operation at the Naval Proving Ground since early July 1955. During July, 117 hours of scheduled calculator time were used to compute or check programs for some thirteen different problems. Checking of subroutines, and further refinement and checking of the NORC compiler was also carried out.

Two-shift operation of NORC was initiated on 1 August 1955, and training of maintenance and operating personnel is being performed toward an objective of three-shift operations.

The schedules for the Aiken Relay Calculator (ARC) and the Aiken Dahlgren Electronic Calculator (ADEC) have been changed to 8 and 12 hours per day, respectively.

NUCLEAR DEVELOPMENT ASSOCIATES, INC. (Automatic Inventory Control System)

Nuclear Development Associates, Inc., White Plains, N.Y., have custom designed an automatic inventory control system for the Otis Elevator Company.

The system, although primarily designed for inventory control, is also capable of performing other office routines, such as automatic purchase order preparation and payroll computation. Information regarding withdrawals from inventory, receipts, and purchase orders placed is typed into the system during the normal working day. In this particular case seven input typewriters are provided, although this number is determined by the work load only, and is not limited by the system itself. During the night the system then digests this information and automatically types out all required information ready for further use at the start of the next working day.

This information includes a list of all inventory items which must be re-ordered and the quantity to be ordered; a list of all items which are on shortage, the manufacturing orders affected by these shortages, and the purchase orders outstanding for these items. Thus purchasing, expediting, and production scheduling are greatly simplified.

The system determines when, and how much, to re-order by calculating the most economical quantity of each item to be kept in inventory. This calculation takes into account the base price and quantity discount schedule for each item, its past usage over the last 15 months and the fluctuations in that usage, the future business forecast, the lead time of the item, and the costs of maintaining inventory, placing purchase orders, and clearing up shortages.

Apart from its daily output, the system also maintains a continuous, up-to-date record of all items in inventory, their usage, amount on hand, and on order, open orders outstanding, and other pertinent information.

MIDAC (University of Michigan)

Beginning July 1, 1955, because of the necessity for keeping up with the computational load originating in the Engineering Research Institute and from graduate students and staff members of the University of Michigan, the MIDAC began operation on a 168-hour week.

During the month of July, despite the availability of only two full-time engineers for maintenance of the computer, the MIDAC operated productively for an average of 75% or 126 hours of each 168-hour week. During August, the percentage was 74%. Major trouble continued to be from input-output, with magnetic drum relay switching and acoustic-delay line storage following in order of difficulties encountered. Very little down time could be traced to the packaged electronic circuitry in the central computer. Because of performance of one problem requiring complete checking of all storage and input-output, a complete log of all machine errors was obtained over periods ranging up to 24 hours of consecutive machine operation time.

The MAGIC I (Michigan Automatic General Integrated Computation) system of automatic coding, a translater-compiler-assembler, has been in use now for over six months, while the EASIAC (Easy Instruction Automatic Computer), an automatic coding scheme of the translater-interpreter type, has been in use for over a year. The MAGIC scheme provides for storage of commonly used subroutines on the MIDAC magnetic drum, complete conversion and translation of external numbers and instructions in decimal and floating address form to internal binary, and associated punch-out, mistake diagnosis, and post mortem routines called in automatically. All newcomers to MIDAC coding are trained using this system, and almost no use is made of the machine's original hexadecimal notation. The EASIAC system is a completely decimal, floating point number scheme, with seven B-lines, floating address instructions, standard square root, trigonometric, exponential and logarithmic functions as operations, and complete mistake analysis built in. Although it operates relatively slowly, nevertheless it has been used successfully in instructing students in all University classes before moving on to the more complicated MAGIC notation.

Work continues on the MIDAC subroutine library, which includes all standard functions, and task routines for all matrix operations, fixed and floating point, integration of ordinary differential equations, determination of eigenvalues, a complex number interpretive routine, automatic rollback procedures, and numerous programs coded by students or staff members on research problems.

Recent additions to the machine include a parity check on all words entering or leaving high-speed (acoustic delay-line) storage, an automatic memory sum of all information transferred to and from secondary (drum) storage, and modification of a standard Ferranti paper-tape reader to use photodiodes located just below the sensing holes. A new drum, combined with increased packing density of information, is to be added to the computer in October, with a resulting increase in secondary storage of over 25,000 words.

Four University courses now make use of the computer's facilities for educational purposes: Methods in High-Speed Computation I (Computer Programming), Methods in High-Speed Computation II (Numerical Analysis), Digital Computer Technology, and Digital Computers for Air Force Officers. Over 85 students actually solved problems, using one of the two coding systems mentioned above, on the MIDAC. In addition, computations on MIDAC were integral parts of three Ph.D. theses during the past school year.

From August 1 through 12, 160 persons attended the University's third annual Special Summer Conference in Digital Computers and Data Processors. The sessions were divided in three headings: Engineering and Logical Design, Business Data Handling, and Scientific and Engineering Computation. Students had available for programming instruction sessions on the MAGIC and EASIAC systems, and on the IBM-650, Bendix G-15, and UNIVAC 120 computers, all of which were available for actual operation. Seventeen representatives of computing and data-processing groups around the country, operating such machines as ILLIAC and ORACLE, Whirlwind I, SEAC, UNIVAC, ERA-1103, IBM-701, IBM-702, IBM-650, ElectroData Datatron, CRC-102, Elliott Brothers WREDAC, and MIDAC, gave a series of "Reports from the Users" to the group. These reports, taken by verbatim stenotypist transcription, are being incorporated in an approximately 1000-page set of notes being edited by J. W. Carr and Norman Scott, and including a description of all lectures given over the two-weeks' period. Copies of the notes

may be purchased from "Special Summer Conferences, College of Engineering, University of Michigan, Ann Arbor, Mich."

The following problems indicate the range and variety of uses of the MIDAC over the past six-months period:

Design of a Traveling-wave tube
English-to-French Automatic Dictionary
Simulation of Traffic Behavior at a Traffic-Light Intersection
Transients in a Nuclear Reactor
Calculation of Light-Scattering from Spheroidal Particles
Monte-Carlo Calculation of Semi-Conductor Energy-Levels
Analysis of Logical Networks
Pipe Stresses in a Steam-Generating Plant
Multi-Component Distillation Column Analysis
Predictions of Cycles in Economic Theory
Development of a File System for Military Use
Design of Lenses by Bending
Calculation of Thermodynamic Tables for Freon
Probit Analysis of Vision Experiments
Mutation Rate Study for Atom-Bomb Victims
Optical Reflection Coefficients of a Diffraction Grating
Dispersion of Cosmic Rays in Atmosphere
Composition of Sun's Interior

ORACLE (Oak Ridge National Laboratory)

Installation and testing of the magnetic tape memory for the Oracle was completed in June, and the new unit is now being used operationally. The unit contains four tape drives with the following characteristics:

Tape width:	2 inches, 42 channels
Tape speed:	47 inches per second
Packing density:	100 pulses per inch
Block length:	128 words per block, 40 binary bits per word
Tape length:	2.41 inches per block including dead space for start up and stop.

Of the 42 channels, 40 are for information, one channel for control and one channel is used for an odd-even parity check bit. A full reel of 1,200 feet of tape will store approximately 800,000 Oracle words of 40 bits each. Although words are packed 128 per block, an arbitrary number of words may be written or read in either direction on the tape.

PENNSTAC (The Pennsylvania State University)

Wiring of the PENNSTAC memory is complete and engineering activity is now concentrated on placing the memory in operating condition. Wiring of the arithmetic and control units is still under way, but is expected to be completed shortly. Wiring of the console is also to be completed soon. The design of the input-output equipment is in progress and preliminary tests of this equipment are being made. The air conditioning equipment has arrived and is being installed.

Dr. Donald Laird has begun to consider preparation of programs for PENNSTAC, and will act as chief programmer for the machine. Prof. Carl Volz and Mr. Channing Morrison are designing the input-output circuitry.

REMINGTON RAND (Automatic Programming)

The development of "electronic dictionaries" or automatic programming for Remington Rand Univac Systems, turning months of problem preparation time into a matter of minutes, is announced by Remington Rand's Electronic Computer Department.

Automatic programming, tried and tested since 1950, eliminates communication with the computer in special code or language. Users can use their own common language, in terms of mathematicians' equations and symbols, or in plain everyday business English.

The automatic program, in effect, is a dictionary permitting the machine to translate succintly expressed programmers' wishes into routines of instructions—automatically, swiftly, and with complete accuracy. It is not a piece of equipment, but a new and powerful programming technique.

Two basic types of automatic programming have been developed and designed for the Univac: interpretive routines and compiling routines or compilers. "Interpretive routines" which translate a master program into computer code and at the same time perform the required operations, are especially useful in mathematical and scientific work. Commercial programs preparation make use of the "compiling routine" which translates the master program into computer code and records the finished program for further purposes. The compiling routine decodes the master program, selects standard sub-routines from its "dictionary," generates other sub-routines where necessary, allocates memory space, assembles all the sub-routines into a finished program and finally records the program on magnetic tape. The program tape prepared by the compiler is then used in the processing of information. The "compiling routine" is particularly adaptable to industry, business and commerce.

Two automatic programs of the interpretive type—the Short-Order Code and the Analytical Differentiator—are available. The Short-Order Code is in effect an engineering "electronic dictionary" and the Analytical Differentiator is a mathematical "electronic dictionary." The Short-Order Code actually is an interpretive routine designed for the solution of one-shot mathematical and engineering problems. The Analytical Differentiator is an interpretive routine used for solving problems in higher mathematics.

The A-2 Compiler, another "electronic dictionary" first released in 1952, is widely used in the solution of scientific and engineering problems. Familiarity with the Univac Code is not required; the programmer lists the operations he wants performed in what is known as "pseudo-code," in which three letters or numbers may specify a routine of hundreds of Univac instructions.

The A-2 Compiler has been used to produce Univac programs for such diversified problems as: the design of a nuclear reactor; studies of bearing lubricant for industrial research institutes; studies of equipment mortality for a large public utility, involving complex mathematical analysis, prepared in six minutes; the characteristics and behavior of gases in a jet stream under about 1,900 sets of conditions, prepared and ready in ten minutes.

Three other automatic programs of "electronic dictionaries" are currently in the final stages of development: Generalized Programming; Bior; and B-zero, the Data-Processing Compiler. All three are designed to reduce further the time required for programming and increase the accuracy of overall data-processing operations.

B-zero, the Data-Processing Compiler, is a general purpose compiler that does not require familiarity with the Univac in any way. It will accept pseudo-codes ranging from mathematical notation (for scientific problems) to plain business English (for commercial problems).

Insurance, chemical, steel and appliance manufacturing companies are current users of Remington Rand automatic programming.

The development of automatic programming—"electronic dictionaries"—makes the computer do the actual work of instructing itself, eliminating the tedious and time-consuming programming work of analysis, processing, coding, writing and checking programs of instructions for electronic computers.

WHIRLWIND I

Applications

During April to June, the Scientific and Engineering Computation Group, in conjunction with various departments at MIT, processed 74 problems for solution on Whirlwind I. These problems are described in the Project Whirlwind Summary Reports submitted to the Office of Naval Research and cover some 18 different fields of applications. The results of 27 of the problems have been or will be included in academic theses. Of these, 19 represent doctorate theses, 3 Engineering, 7 master's and one bachelor's. Thirty-three of the problems have originated from research projects sponsored at MIT by the Office of Naval Research.

Academic

The Digital Computer Laboratory programming course was given once during this quarter. The course includes the following topics: relative addresses, temporary storage, floating addresses, preset parameters, programmed arithmetic, cycle counters, buffer storage, automatic output, post mortems, and multipass conversion. The text for the course is a programmer's manual written by staff members of the Scientific and Engineering Computation Group. The 26 students enrolled during this quarter represented the following groups: Department of Business and Engineering Administration, School of Industrial Management, Department of Nuclear Engineering, Spectroscopy Laboratory, Laboratory for Nuclear Science, Naval Supersonics Laboratory, Chemical Engineering Department, Physics Department, Solid State and Molecular Theory Group, Aeronautical Engineering Department and Lincoln Laboratory.

COMPUTERS, OVERSEAS

ELLIOT BROTHERS (LONDON) LIMITED

ELLIOTT 402 ELECTRONIC DIGITAL COMPUTER

The first production model of the Elliott 402 Electronic Digital Computer, as described in the April 1955 edition of the Digital Computer Newsletter, has now been running at the Institut Blaise-Pascal, Paris, for nearly six months. On installation this computer completed one week's acceptance tests without a single fault.

Another production 402 has been running at Elliott's Research Laboratories at Borehamwood, Hertfordshire, for two months; this raises the strength of Elliott's computing service to three computers, the others being a laboratory-built 402 and an earlier machine. Further 402 models are under construction; Elliott are now supplying computers at the rate of one 402 (or its equivalent) per month.

ELLIOTT 403 ELECTRONIC DIGITAL COMPUTER

This computer consists of an assembly of 22 cabinets containing 640 standardized plug-in units (as used in the 402), incorporating 1,600 tubes, a magnetic disc store of 16,384 34-digit words capacity, a quick access store consisting of 512 words on magneto-strictive nickel delay lines, two magnetic tape units, mains-isolated stabilized power supplies, and a built-in control console.

This machine was built to a customer's specification.

ELLIOTT 405 ELECTRONIC DIGITAL COMPUTER

The Elliott 405 Unit-Construction Business Computing System was announced at the May 1955 National Conference of the Office Management Association. This system is primarily intended for business, accounting and data-processing applications.

It consists of a basic unit (Systems Centre) to which one or more other units (Input, Output or Storage) can be connected, the additional units being chosen to meet the need of the individual user. Further units can be added as requirements dictate.

SPEEDS -

Digit Rate	333,000 per second
Word Length	34 digits (32 active + 2 gap)
Word Time	102 microseconds
Addition, subtraction, etc.	102 microseconds
Multiplication and division (independent of sign)	3.3 milliseconds.

SYSTEM CENTRE - (3 cabinets) -

This is a self-contained basic computer, including a power unit, control and arithmetic functions, and 128 words of quick access nickel delay-line storage. Additional power units may be required for large installations.

CONTROL UNIT -

Three alternative control units are available; these are:

(a) a small unit about typewriter size, containing only the essential operating controls.

(b) a console similar to that used in the 402 computer, with extensive monitoring and test facilities (two cabinets).

(c) a console designed for the 405, but separated from the computer, which has comprehensive lamp displays as well as operating and test facilities.

INPUT UNITS -

Teleprinter tape readers are available at a speed of 150 teleprinter characters per second. A Punched Card Reader (1 cabinet) reads standard 65 or 80 column cards at a speed of 600 per minute. The card feed is a single-shot operation directly under computer control.

MEMORY UNITS -

Additional quick access nickel delay line storage up to a maximum of 512 words is available. Usually this 'inside storage' is part of another unit. The magnetic drum storage unit (as used in the 402) - (2 cabinets), and the magnetic disc storage unit (as used in 403) - (3 cabinets), each include 128 words of nickel line storage. Drum capacity is 32 tracks, each containing 128 words. Total: 4,096 words. Speed of rotation: 4,600 r.p.m. Disc capacity is 64 tracks, each containing 256 words. Total: 16,384 words. Speed of rotation: 2,300 r.p.m.

ANCILLARY MEMORY UNITS -

The Elliott Multi-channel Magnetic Film Unit, (2 cabinets), uses 35 mm. film coated with magnetic oxide as memory device. Each 1,000-ft. reel of film contains 300,000 words. Speed: 30" per second.

Alternatively, quarter inch magnetic tape may be used as memory device, (3 cabinets). Each 1,500-ft. reel of tape contains 50,000 words. Speed: 100" per second. Included in either of these units are 64 words of quick-access nickel line storage.

Additional slave units (1 cabinet for film, 2 cabinets for tape), may be added as required.

OUTPUT UNITS

Tape perforator, (33 characters per second) and page printer, (69 characters per line).

Electric typewriter, where wide carriage facilities are required.

Line-at-a-time printer (92 characters per line), operating at a speed of 150 lines per minute.

High-speed magnetic tape output, at a speed of 300 characters per second, subsequently interpreted on teleprinters or typewriters by means of simple conversion equipment.

ORDER CODE

Single address; Two orders per word; Block transfer facilities into, out of and within, the quick access store. Two storage locations may be used as B-lines for modifying instructions.

DERA (The Darmstadt Electronic Digital Computer)

Characteristics

Serial digit-by-digit operation

Main memory: Magnetic drum with pulse timing unit

Rapid-access ferrite core memory

Decimal arithmetic mode

One address instructions

Address modifier (Adressenrechenwerk): Special electronic index registers with ferrite cores for automatic address modification and counting

Input: Punched cards or punched tape

Output: Line printer of a BULL tabulating machine, typewriter, punched cards or punched tape

Components: 1,400 tubes, 6,000 diodes, 150 relays

Number representation

Decimal number system

Each decimal is represented by 4 binaries (excess-3 code)

Word: One 13-place decimal number plus sign (+ represented by 0
- represented by 9)
or two 7-place decimal orders (half word)

Negative numbers are represented by nines' complement

Fixed decimal point lies behind sign place

Floating point operation by subroutines and auxiliary technical equipment for separate handling of mantissa and exponent

Pulse frequency: 200 kc

All number pulses are handled in a single channel, the lowest value at first

Memory

Magnetic drum with vertical axis, 3,000 rpm, 16 inch diameter, 4 inches high

Capacity: 3,000 words or 6,000 half words, 60 tracks,
3.3 pulse positions/mm (80 per inch)
Maximum access time: 20 msec
Memory content can be indicated on CRT

Pulse timing unit: 5-track high-precision timing pulse gear wheel with 4,200 soft-magnetic teeth on non-magnetic ground material. Precise slots are milled in the nickel plated circumference of the timing ring.

Teeth and spaces .006" wide
Timing pulses are recorded by 5 reading-heads and operate a decimal frequency divider
The timing unit is fixed to the rotor of the magnetic drum

Rapid-access memory: Matrix with 5,600 ferrite cores

Capacity: 100 words or 200 half words

Arithmetic unit

Logical and arithmetic components: Networks with Ge-diodes and resistors, flip-flops, converters, cathode followers, pulsing units, delay-lines with ferrite cores

One track of the magnetic drum is used as accumulator

For multiplication the arithmetic unit produces the quadruple values of multiplicand (Md). Partial products are combined by ± Md and ± 4 Md

Division is made by successive subtraction until zero

Computing time:	Addition and subtraction:	0.8 msec
	multiplication:	12 - 16 msec
	division:	35 - 125 msec

No access time is required because numbers are stored in the ferrite code matrix memory

Number transfer from the main memory (magnetic drum) to the rapid-access memory (ferrite cores) is programmed by compiling routines

Control unit

One address instructions are stored on the drum in spaces of 5 words

One instruction: 7-place decimal numbers (half word)

1st and 2nd decimal number indicates the operation according to the instruction list
3rd decimal number indicates the operation treated by the address modifier
4th till 7th decimal number indicates the address

Address Modifier (Adressenrechenwerk): This special index register is a little arithmetic unit with Ge-diode-networks and ferrite core matrices. It performs address modification parallel to the main computer program.

Subroutines: Floating point operation—Computing with complex numbers—Computing with double accuracy—Computing with half accuracy—Elementary functions

Subroutines for higher transcendental functions and for standard procedures of practical analysis (differential equations, simultaneous linear equations, non-linear algebraic equations) are being developed.

Input and output

DERA is connected with a BULL punched card unit by two buffer tracks on the magnetic drum

Parallel-serial conversion by networks

Information of a punched card with 80 columns is transferred into DERA within 0.4 sec. During this transfer DERA continues computation.

The line printer of the tabulating machine prints 92 alphanumeric characters within 0.4 sec; that means 230 characters/sec.

Punched card input, printing, and card punching may be performed simultaneously.

Output in analog form is under development.

COMPONENTS

IBM INPUT OUTPUT EQUIPMENT

High Speed Printer

IBM has announced the IBM 719 and 730 printers which prepare business documents at a rate of 1,000 lines a minute. Characters are formed by the "wire printer" technique.

New Accessories for 650 Magnetic Drum Data Processing Machine

Input and output for this machine has until now been by punched card. Now the 650 is also available with tape input and output, and with printer output. The tapes are compatible with the 700-series machines. Printed output for the 650 will be obtained by coupling it directly to a 407 accounting machine.

NEW ELECOM 50 INPUT-OUTPUT EQUIPMENT AVAILABLE

Punched tape input-output facilities now are offered with the ELECOM 50, Underwood-ELECOM's drum memory, electronic accounting machine. Punched tape reading and punching speeds are twenty characters per second.

PUNCHED CARD READER

A punched card reader suitable for use with 90-column 6-hole code punched cards has been developed at the Chemical Corps installation at Camp Detrick, Frederick, Maryland as a source of input for typewriter operation. Present speed of the machine is 8 characters per second with 2 seconds per card required for clearance and card feeding. The entire capacity of a six element code (63 characters or operations) is obtainable from the card. Output in the simplest case is in the form of a pulse on one or more of six wires corresponding to punched holes in one column of the card. By use of an external translate unit or decoding tree, the machine may be made to operate any serially operating electro-magnetically controlled data handling device within its speed range capabilities.

WANG LABORATORIES (Analog-Digital Converters)

Wang Laboratories, Cambridge, Massachusetts, announce a new complete line for converting shaft positions to digital form. The "non ambiguous" coded types provide resolution of 1,000 parts for 320, 324, 336 and 360 shaft rotation (Models 3C, 3B, 3D and 3A). The 'incremental coded" type provides various models between 100 increments and 1,000 increments per 360°.

MISCELLANEOUS

BURROUGHS RESEARCH CENTER EXPANSION

The Burroughs Corporation's research and development program in electronics, electromechanics and magnetics is expanding into two new million-dollar electronic experimentation buildings near the Corporation's two-year-old Research Center in Paoli, Pennsylvania.

These new buildings, which will provide 60,000 additional square feet of working space will bring the Company's total working space in the suburban Philadelphia area to 168,000 square feet.

ELECOM 125 PROGRAMMING COURSE

A course has been announced covering programming techniques for the Elecom Model 125 Electronic Computer and Elecom File Processor. It will be given at the Electronic Computer Division plant in Long Island City. Admission is by invitation and no fee is charged. Dates for the next course are from 24 October to 4 November 1955. Early indication of interest in attending will be appreciated.

ELECTRODATA MOVES INTO NEW PLANT

ElectroData Corporation, manufacturer of DATATRON electronic computers, has completed moving personnel and equipment into its new 40,000-square-foot plant in Pasadena's Hastings Ranch section, just north of Consolidated Engineering Corporation, parent affiliate, at 460 Sierra Madre Villa.

The new building, designed for threefold expansion on the same five-acre site, brings together ElectroData operations which formerly occupied four separate locations in Pasadena.

The new plant houses administrative, research and manufacturing facilities, as well as international headquarters for marketing services. The company maintains branch sales and service offices throughout the U.S. and Canada.

NEW HEAD OF RESEARCH DIVISION, FERRANTI ELECTRIC LIMITED

Dr. A. Porter, previously head of the Research Division of Ferranti Electric Limited, has returned to England to take over the Chair of Light Electrical Engineering at The Imperial College of Science and Technology.

His place as Head of the Research Division has been taken over by Mr. M. K. Taylor, who was previously Assistant Head of this Division.

CONTRIBUTIONS WANTED FOR DIGITAL COMPUTER NEWSLETTER

The Office of Naval Research welcomes contributions to the Digital Computer NEWSLETTER.

The NEWSLETTER is published four times a year on the first of January, April, July and October and material should be in the hands of the editor at least one month before the publication date in order to be included in that issue.

Short technical articles on new machines, on new developments in digital techniques and components, on new types of problems solved and news items which may be of potential interest to government users are desired.

The NEWSLETTER is circulated to all interested military and government agencies, and to contractors of the Federal Government. In addition, it is being reprinted in the Journal of the Association for Computing Machinery.

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